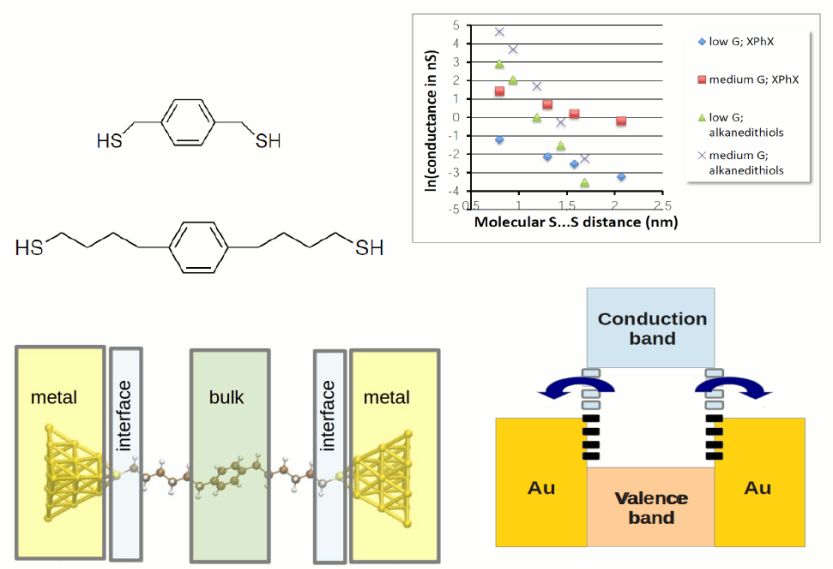

P8

Magnetic Force Microscopy Of Focused Ion Beam Patterned Co Antidot Arrays

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Continuous magnetic films with patterned groups of ordered holes, known as *magnetic antidot arrays*, are being intensively investigated as candidates for high-density storage media [1] and as magnonic crystals for magnetic logic applications [2]. The main parameters that influence the magnetic properties of the array are its symmetry and lattice constant and the shape and size of the antidots. The main focus of antidot arrays studies has been on square or hexagonal symmetry arrays of circular antidots, on the μm- and sub-μm-scale, fabricated by patterning methods like UV [3] or e-beam [4] lithography. On the other hand, nm-scale antidot arrays can be attained by various self-assembly techniques employing, e. g., porous anodic alumina [5] or colloidal lithography [6]. However, there are significant inherent drawbacks in all of the self-assembly fabrication methods, mainly regarding the limitations in the array symmetry and/or size and the extent of the symmetric domains, which is on the order of some μm

In this work, nm-scale antidot arrays have been fabricated using focused ion beam nanopatterning and characterized by magneto-optical Kerr effect magnetometry and atomic/magnetic force microscopy. Continuous Ti (2 nm)| Co(10 nm) | Au(10 nm) stacks were evaporated in an ultra-high vacuum chamber on monocrystalline (0001) sapphire substrate. The substrate was rotated around its normal during the deposition in order to avoid the formation of strong magnetic anisotropy during the growth of the film. The antidot arrays

were directly etched on the continuous stack using an IonLine FIB machine, with Ar ions at energy of 30 keV and ion current of 6.9 pA. Square and hexagonal symmetry arrays have been studied with lattice constant ranging from 150 nm to 300 nm and antidot diameter 55 nm, see Fig. 1. We find an intense increase of the magnetic coercivity (Hc) of the film after patterning, with a monotonic increase of Hc as the density of defects increases. Additionally, the in-plane anisotropy axes of the patterned film depend strongly on the array symmetry, with alternating hard and easy axes following the array symmetry. High resolution MFM images reveal the magnetic structure of the arrays. In clear contrast to the unpatterned film, where abrupt contrast changes correspond to domain wall dragging under the influence of the magnetic stray field of the MFM tip (Fig. 2a), the antidot arrays exhibit stable magnetic domains whose inner structure is commensurate to the array symmetry (Fig. 2b-2d). It is concluded that nanopatterned anti-dot arrays provide an effective means to engineer the magnetic properties of thin films.

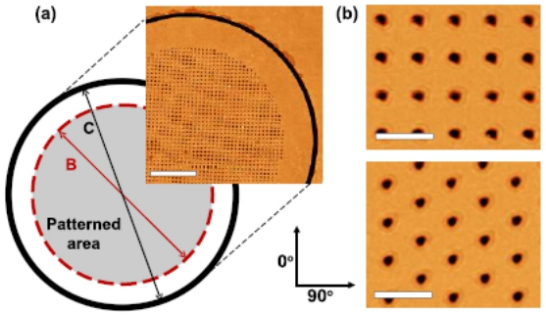

Figure 1. Atomic force microscopy images revealing (a) the global morphology of a representative antidot array and (b) the two array symmetries studied and the antidot shape and size.

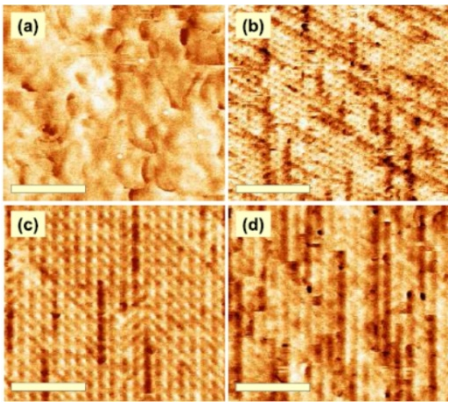

Figure 2. MFM images of (a) unpatterned Co film, (b) hexagonal antidot array demagnetized along 0o, (c) square antidot array demagnetized along 45o, and (d) square antidot array demagnetized along 30o

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P9

Investigating Subsurface Boron Dopants In Si(111)-(√3x√3) R30° Using Simultaneous Nc-AFM/STM And DFT

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